NASA Glenn Research Center – Single Spool Turbine Facility
Torquemeter Draft Statement of Work

The NASA Glenn Research Center in Cleveland, Ohio, USA, plans to conduct research measurements on turbine sections of aircraft propulsion systems. Accurate measurement of overall turbine performance requires accurate measurement of torque and rotational speed. The research will be conducted in NASA's Single Spool Turbine Facility located in Building 23, Test Cell W-6A. The turbine power will be absorbed by a large synchronous motor/generator that can run up to 1,800 rpm. The turbine is connected to the synchronous machine through a 7.87:1 gearbox a with double herringbone gear set. A high-speed, high accuracy torquemeter and coupling system is needed to connect the gearbox to the turbine bearing cartridge. The turbine test articles will have on-board rotating instrumentation, so the high-speed driveline, including the torquemeter, shafts, and couplings; shall be bored to accommodate a wire bundle passing from the turbine to a slip ring located at the opposite end of the high-speed gearbox shaft. The purpose of this document is to define the specifications, performance requirements, and scope of work to allow a supplier to submit a quote for the:

- Design, fabrication, and calibration of a torquemeter, coupling, and high-speed shaft system.
- Design and fabrication of a torquemeter pedestal support mount as an optional procurement with separate pricing.
- Development of all required documentation, including a rotor dynamics report
- Shipment of all components to the NASA Glenn Research Center, Cleveland, Ohio.

The turbine test articles could operate in either rotational direction. The operation of the facility will be as follows: The synchronous machine will be started as a motor with the turbine under a vacuum and will take the turbine up to a relatively low idle speed (approximately 1,400 rpm) at low torque. The turbine inlet air valves will slowly be opened and the direction of torque will reverse with the synchronous machine running as a generator. That will be the normal operating mode for turbine testing.

The first turbine test article will be representative of a high-pressure aircraft engine turbine and will run a relatively high speed and lower torque. Future turbines may be representative of low-pressure turbines and will run at relatively low speed and higher torques. The torquemeter and torque sensing element shall be sized to accommodate the specifications below for the first turbine test article and the torquemeter shall be capable of accommodating a torque sensing element for the future higher torque test articles. The future torque sensing element shall be priced separately and quoted as an option.

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The requirements and specifications for the torquemeter and coupling system are as follows:

1. Maximum facility turbine operating speed: 14,000 rpm
2. First turbine test article maximum operating torque = 2,500 ft-lb_f.
3. First turbine test article maximum operating speed = 14,000 rpm.
4. Future turbine test article maximum operating torque = 10,000 ft-lb_f.
5. Future turbine test article maximum operating speed = 3,500 rpm.
6. Torque measurement uncertainty less than 0.15% full-scale.
7. The price shall include static and dynamic torquemeter calibrations and delivery of calibration certificates.
8. The price shall include hardware and instructions for static field calibration of the torquemeter.
9. The price shall include all required signal processing electronic components.
10. Shaft bore diameter for instrumentation wiring: 0.50 inch.
11. Overall high-speed shaft length from the gearbox shaft end to turbine bearing cartridge shaft end: approximately 50 inches.
12. The shaft centerline is approximately 60 inches above the facility bedplate. The torquemeter shall be pedestal-mounted. It is desired that a pedestal mount for the torquemeter with an axial accelerometer mount with 6-32 UNC thread be quoted as an option separately. Details will be provided by NASA of existing structures that would need to be considered when designing pedestal geometry
13. A lubrication system price shall be included in the quote if such a system is required for operation of the torquemeter. If a lubrication system is required, NASA will locate it in the basement below the facility. The elevation difference between the basement floor and the shaft centerline is 22 feet. Fitting connections between the lubrication system and torquemeter shall be NPT. Adapter fittings are acceptable.
14. The torquemeter shall have horizontal and vertical accelerometer mounts with 6-32 UNC tapped threads at a depth of at least 0.25”

15. The torquemeter signal and temperature compensation cables shall be at least 12 meters in length.

16. Type K thermocouples shall be used for all temperature measurements.

17. Provide a rotor dynamics report of the entire shaft line from the turbine flange to the gearbox flange that identifies any axial, vertical, horizontal, or torsional critical speeds.

18. All facility pipe or tubing connections to the equipment shall utilize standard American threads such as NPT, 37 deg flare, or Swagelok. Adapter fittings are acceptable.